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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/892,586	06/27/2001	Paul Turner	1086.2002-001	2279

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EXAMINER	
SHARON, AYAL I	

ART UNIT	PAPER NUMBER
2123	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	02/06/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No.	Applicant(s)	
	09/892,586	TURNER ET AL.	
	Examiner	**Art Unit**	
	Ayal I. Sharon	2123	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11/9/2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-25* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *23 and 24* is/are allowed.

6)☒ Claim(s) *1-22 and 25* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *8/13/01* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *10/6/06*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Introduction

1. Claims 1-25 of U.S. Application 09/892,586 are pending.
2. The case claims priority to provisional application 60/214,875, filed on 06/29/2000.
3. The new grounds of rejection have been necessitated by Applicants' amendments to the claims.

Continued Examination Under 37 CFR 1.114

4. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 11/9/2006 has been entered.
5. The claim amendment filed on 10/6/2006 has been entered.

Allowable Subject Matter

6. The following are statements of reasons for the indication of allowable subject matter.

7. The relevant prior art is:
   - Klimasauskas et al., U.S. Patent 5,877,954. ("**Klimasauskas**").
   - Bhat et al., U.S. Patent 5,477,444. ("**Bhat**").
   - Lightbody, et al. "Neural Network Modelling of a Polymerisation Reactor". Int'l Conf. on Control, 1994. March 21-24, 1994. Vol.1, pp.237-242. (Hereinafter "**Lightbody**").
   - Weisstein, Eric W. "Hyperbolic Tangent." From MathWorld. © 1999 CRC Press. http://mathworld.wolfram.com/HyperbolicTangent.html. (Hereinafter "**Weisstein**").
8. **Independent Claims 23-24 are allowed.**
9. The following are the Examiner's reasons for allowance:
   - Neither Klimasauskas nor Bhat expressly teach the use of "the log of a hyperbolic cosine function".
   - Lightbody expressly teaches the use of "hyperbolic tangent nodes" in a non-linear neural network used for polymer process control (See Lightbody, p.239, right column, next-to-last paragraph). Examiner interprets that these nodes perform the same purpose as the claimed "transfer function" in the non-linear network model claimed in Claim 16. However, Lightbody is silent in regards to an integration, summation, or accumulation of the hyperbolic tangent function.

     Moreover, Lightbody does not expressly teach the use of "the log of a hyperbolic cosine function" as in the limitations of Claims 6, 16, and 22:

- Weisstein teaches at the bottom of p.2 that the integral of hyperbolic tangent equals the natural log of hyperbolic cosine, plus some constant. However, since neither Klimasauskas , nor Bhat, nor Lightbody teach an integration, summation, or accumulation of the hyperbolic tangent function, there is no express motivation to combine Weisstein with either Klimasauskas, or Bhat, or Lightbody.

10. None of the cited prior art references, either alone or in combination with one another expressly teach the limitation of "the log of a hyperbolic cosine function" in combination with the other claimed features.

11. **Claims 6, 16, and 22 contain allowable subject matter, but stand rejected under 35 USC § 112.**

12. In regards to Claims 6, 16, and 22,

    - Neither Klimasauskas nor Bhat expressly teach the use of "the log of a hyperbolic cosine function".
    - Lightbody expressly teaches the use of "hyperbolic tangent nodes" in a non-linear neural network used for polymer process control (See Lightbody, p.239, right column, next-to-last paragraph). Examiner interprets that these nodes perform the same purpose as the claimed "transfer function" in the non-linear network model claimed in Claim 16. However, Lightbody is silent in regards to an integration, summation, or accumulation of the hyperbolic tangent function.

Moreover, Lightbody does not expressly teach the use of "the log of a hyperbolic cosine function" as in the limitations of Claims 6, 16, and 22:

- Weisstein teaches at the bottom of p.2 that the integral of hyperbolic tangent equals the natural log of hyperbolic cosine, plus some constant. However, since neither Klimasauskas , nor Bhat, nor Lightbody teach an integration, summation, or accumulation of the hyperbolic tangent function, there is no express motivation to combine Weisstein with either Klimasauskas, or Bhat, or Lightbody.

13. None of the cited prior art references, either alone or in combination with one another expressly teach the limitation of "the log of a hyperbolic cosine function" in combination with the other claimed features.

Claim Rejections - 35 USC § 112

14. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

15. Claims 1-22 and 25 rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for a polymer process controller (see p.17, lines 27-30) and a financial controller (see p.18, lines 1-5 of the specification), does not reasonably provide enablement for controlling other real world applications. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to use the invention

commensurate in scope with these claims. The claim is directed to a computer-implemented mathematical algorithm used in a controller, yet the applicant only disclose these two very different possible applications for the invention - a polymer process controller, and a financial controller.

16. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

17. Claims 1-9, 11-19, 21, and 25 are rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. See MPEP § 2172.01. The omitted steps are: a step that explains how the constrained model provides precision control in the absence of a controller. Dependent claims 10 and 20 remedy this defect.

Claim Rejections - 35 USC § 101

18. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

19. **Claims 1-22 and 25 are also rejected under 35 U.S.C. 101 because the claimed invention preempts a 35 U.S.C. 101 judicial exception. The claims preempt every "substantial practical application" of an idea – a mathematical algorithm.**

20. One may not patent every "substantial practical application" of an idea, law of nature or natural phenomena because such a patent "in practical effect be a patent on the [idea, law of nature or natural phenomena] itself." Gottschalk v. Benson, 409 U.S. 63, 71-72, 175 USPQ 673, 676 (1972).
21. According to MPEP § 2106 (IV)(C)(3), a claim that recites a computer that solely calculates a mathematical formula (see Benson) or a computer disk that solely stores a mathematical formula is not directed to the type of subject matter eligible for patent protection.
22. All of the claims in the instant application share this defect. In particular, none of the independent claims are restricted to any field of application, and therefore the claims are directed to all possible applications of the math recited in the claims.
23. The relevant prior art and contemporaneous art recites a variety of unrelated practical applications for the claimed mathematical results of the claimed modeling of a non-linear process. For example, the instant specification discloses two unrelated applications, polymer process control, and financial control.
24. The only commonality between these different uses is the underlying mathematics.
25. Applicant's claims are directed broadly to any practical use of the mathematics in a controller. Examiner therefore has determined that the claims attempt to patent every "substantial practical application" of an idea – a mathematical algorithm. Thus, the claims are non-statutory.

Claim Rejections - 35 USC § 103

26. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

27. The prior art used for these rejections is as follows:

- Klimasauskas et al., U.S. Patent 5,877,954. ("**Klimasauskas**").
- Bhat et al., U.S. Patent 5,477,444. ("**Bhat**").

28. Claims 1-5, 7-15, and 17-21 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Klimasaukas in view of Bhat.

29. In regards to Claim 1, Klimasaukas teaches the following limitations:

1. A method for modeling a non-linear empirical process, comprising the steps of

creating an initial model generally corresponding to the non-linear empirical process to be modeled, the initial model having a base non-linear function an initial input and an initial output;

(See Klimasaukas: col.2, lines 27-31, where Klimasaukas teaches: "The neural network model is suitable for modeling complex chemical processes such as non-linear industrial processes ...")

constructing a non-linear network model based on the initial model, the non-linear network model having multiple inputs based on the initial input and a global behavior for the non-linear network model as a whole that conforms generally to the initial output, <u>the global behavior being at least in regions of sparse initial input</u>; and

(See Klimasaukas: col.2, lines 36-38 and 47-50; and col.8, lines 55-61, where Klimasaukas teaches: "For instance, when training data is limited and noisy, the network outputs may not conform to known process constraints."

And where Klimasaukas also teaches: "As a result, compared to other linear regression models, the PLS model works well for the cases where input variables are correlated and the data are sparse.")

calibrating the non-linear network model based on empirical inputs by using a bound on an analytical derivative of the base non-linear function

(See Klimasaukas: col.12, lines 63-66, and col.13, lines 6-9,

where Klimasaukas teaches: "The neural network is trained to predict the difference between the primary model predictions and the target variables."

And where Klimasaukas also teaches: "Further, in the event that the primary analyzer 132 deploys a derivative calculator at the output 133, the neural network of the error correction analyzer 136 can be trained to predict the error in the derivative of the output 133 of the primary analyzer 132.")

Klimasaukas, however, does not expressly teach the following limitations:

that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated directly from model coefficients, the global properties used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior, the constrained model providing precision control of the non-linear empirical process.

Bhat, on the other hand, expressly teaches the following:

> To control the optimization operations it is also understood that the various manipulated variables **have certain physical limits**, so reflux flow rate limits, reboil steam rate limits and tower pressure limits are provided as inputs to the control system 100. (See col.6, lines 30-34, emphasis added).
>
> In the preferred embodiment a fourth technique is used where certain of the constraints are considered soft constraints and others considered hard constraints. Hard constraints are typically based on physical limits, such as steam rates and steam change rates, and so should not be changed. Soft constraints, on the other hand, are typically those not based on physical concerns but on other concerns. For example, the controlled variable limits are usually imposed but are not physical limits. Thus these soft constraints are more suitable to adjustment. If optimal solutions are not developed within the specified limits of the soft constraints, then in the preferred embodiment, the transfer curve, or value curve in the case of the preferred embodiment, used in the optimization process is slightly altered so that the hard boundaries are somewhat relaxed, so that a transition to zero value for a given concentration occurs, not as a discontinuity or step,

> but as a continuous function. **<u>For example, if the C4 concentration limits are set at 1 and 2 mole percent, then a line is developed between the value curve at the two limits and a near zero point at 0.9 and 2.1 mole percent, with a simple cubic spline smoothing the transitions at all points of discontinuity.</u>** This slightly expanded range allows the optimization process sufficiently more room to operate to allow an optimal solution to be developed and yet not be too far from the desired limits. (See col.9, lines 43-48).

Klimasaukas and Bhat are analogous art because they are from the same field of endeavor – neural networks.

At the time of the invention, it would have been obvious to a person of ordinary skill in the art to modify Klimasaukas with Bhat's teachings. The suggestion/motivation for combining the references would have been Klimasaukas's express teaching that "the input variables may be filtered to using techniques such as that disclosed in [Bhat]." (See col.12, lines 9-12).

Therefore, it would have been obvious to a person of ordinary skill in the art to modify Klimasaukas with Bhat to obtain the invention of Claim 1.

30. In regards to Claim 2, Klimasaukas teaches the following limitations:

> 2. The method of Claim 1, wherein the step of creating the initial model includes specifying a general shape of a gain trajectory for the non-linear empirical process.

(See Klimasaukas: Fig.6, and col.3, lines 3-4, which teaches:

"Thus, the neural network of Fig.6 learns how to bias the primary model to produce accurate predictions.")

31. In regards to Claim 3, Klimasaukas teaches the following limitations:

> 3. The method of Claim 1, wherein the step of creating the initial model includes specifying a non-linear transfer function suitable for use in approximating the non-linear empirical process.

(See Klimasaukas: col.12, lines 57-60, which teaches:

"Preferably, the neurons in the neural network use a hyperbolic transfer function such as (E.sup.x -E.sup.-x).div.(E.sup.x +E.sup.-x) for x values in the range of minus infinity to positive infinity.")

32. In regards to Claim 4, Klimasaukas teaches the following limitations:

> 4. The method of Claim 3, wherein the non-linear network includes interconnected transformation elements and the step of constructing the non-linear network includes incorporating the non-linear transfer function into at least one transformation element.

(See Klimasaukas: col.12, lines 57-60, which teaches:

"Preferably, the neurons in the neural network use a hyperbolic transfer function such as (E.sup.x -E.sup.-x).div.(E.sup.x +E.sup.-x) for x values in the range of minus infinity to positive infinity.")

33. In regards to Claim 5, Klimasaukas teaches the following limitations:

> 5. The method of Claim 4, wherein the step of optimizing the non-linear model includes setting constraints by taking a bounded derivative of the non-linear transfer function.

(See Klimasaukas: col.13, lines 6-9, where Klimasaukas also teaches:

"Further, in the event that the primary analyzer 132 deploys a derivative calculator at the output 133, the neural network of the error correction analyzer 136 can be trained to predict the error in the derivative of the output 133 of the primary analyzer 132.")

34. In regards to Claim 7, Klimasaukas teaches the following limitations:

> 7. The method of Claim 1, wherein the non-linear network model is based on a layered network architecture having a feedforward network of nodes with input/output relationships to each other, the feedforward network having transformation elements; each transformation element having a non-linear transfer function, a weighted input coefficient and a weighted output coefficient; and the step of calibrating the non-linear network model includes constraining the global behavior of the non-linear network model to a monotonic transformation based on the initial input by pairing the weighted input and output coefficients for each transformation element in a complementary manner to provide the monotonic transformation.

(See Klimasaukas: Fig.6, and col.11, lines 61-65, which teaches:

"FIG. 6 illustrates in more detail a conventional multi-layer, feedforward neural network which is used in one embodiment of the present invention as the error correction analyzer for capturing the residuals between the primary analyzer or model 132 output and the target output 115. The neural network of FIG. 6 has three layers: an input layer 139, a hidden layer 147 and an output layer 157."

And also col.9, lines 44-46, which teach:

"... where W is a weighting matrix used to create orthogonal scores and B is a diagonal matrix containing the regression coefficients b_h.")

35. In regards to Claim 8, Klimasaukas teaches the following limitations:

> 8. The method of Claim 1, wherein the step of optimizing the non-linear network model comprises adjusting the optimizing based on information provided by an advisory model that represents another model of the non-linear empirical process that is different from the initial model, the non-linear network model, and the constrained model.

(See Klimasaukas: col.12, lines 63-66, and col.13, lines 6-9)

36. In regards to Claim 9, Klimasaukas teaches the following limitations:

> 9. The method of Claim 8, wherein the advisory model is a first principles model of the non-linear empirical process.

(See Klimasaukas: col.12, lines 63-66, and col.13, lines 6-9)

37. In regards to Claim 10, Klimasaukas teaches the following limitations:

> 10. The method of Claim 1, wherein the non-linear empirical process is part of a greater process, and the method further includes the step of deploying the constrained model in a controller that controls the greater process.

(See Klimasaukas: col.12, lines 63-66, and col.13, lines 6-9)

38. **Claims 11-15 and 17-20 are rejected based on the same reasoning as claims 1-10. Claims 11-15 and 17-20 are computer apparatus claims that recite limitations equivalent to those recited in method claims 1-10 and taught throughout Klimasaukas in view of Bhat.**

39. **Claim 21 is rejected based on the same reasoning as claim 1. Claim 21 is a computer program product claim that recites limitations equivalent to**

those recited in method claim 1 and taught throughout Klimasaukas in view of Bhat.

40. **Claim 25 is rejected based on the same reasoning as claim 1. Claim 21 is a method claim that recites limitations equivalent to those recited in method claim 1 and taught throughout Klimasaukas in view of Bhat.** The "simple cubic spline smoothing" taught in the cited section of Bhat corresponds to the claimed

Response to Amendment

41. The new grounds of rejection have been necessitated by Applicants' amendments to the claims.

42. The Applicants unpersuasively argue (see p.12 of the amendment filed 10/6/06) that Klimasaukas does not teach that the non-near network model has "multiple inputs based on the initial input".

43. Examiner respectfully disagrees. Klimasaukas teaches (see col.8, lines 65-67) that "[b]y running a calibration on one set of data (the calibration set), a regression model is made that is later used for prediction on all subsequent data samples."

44. The Applicants unpersuasively argue (see p.12 of the amendment filed 10/6/06) that Klimasaukas does not teach that the non-near network model has "a global behavior for the non-linear network model as a whole that conforms generally to

the initial output where the global behavior is at least in regions of sparse initial input."

45. Examiner respectfully disagrees. Klimasaukas teaches (see col.8, lines 55-61) that "the PLS approach typically uses a linear regression model which relates the model inputs to the outputs through a set of latent variables. These latent variables are calculated iteratively and they are orthogonal to each other. As a result, compared to other linear regression models, the PLS model works well for the cases where input variables are correlated and the data are sparse."
46. Moreover, Applicants contend (see p.12 of the amendment filed 10/6/06) that Klimasauskas does not disclose or suggest "calibrating the non-linear network model based on empirical inputs by using a bound on an analytical derivative of the base non-linear function that allows global properties such as the global minimum and maximum values of the analytical derivatives to be calculated directly from model coefficients that can be used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior."
47. Examiner notes that these limitations are newly amended. The newly applied rejections address these limitations.
48. Moreover, Applicants contend (see p.13 of the amendment filed 10/6/06) that Klimasauskas discloses a hybrid linear-neural network which uses a <u>fixed linear</u> model that does not produce the claimed "<u>analytically constrained model</u>" of Claim 1.

49. Again, Examiner notes that these limitations are newly amended. The newly applied rejections address these limitations.

50. In regards to new claim 25, Examiner notes that it corresponds to the previous version of Claim 1, before the current amendments. Applicant's arguments regarding claim 25 are addressed in the responses to Applicant's arguments regarding claim 1.

Correspondence Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ayal I. Sharon whose telephone number is (571) 272-3714. The examiner can normally be reached on Monday through Thursday, and the first Friday of a biweek, 8:30 am – 5:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Leo Picard can be reached at (571) 272-3749.

Any response to this office action should be faxed to (571) 273- 8300, or mailed to:

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Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Tech Center 2100 Receptionist, whose telephone number is (571) 272-2100.

Ayal I. Sharon
Art Unit 2123
February 2, 2007

2/2/07

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